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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/816,168	04/02/2004	Tsutomu Nakada	NAKADA11	7874

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EXAMINER	
WONG, EDNA	
ART UNIT	PAPER NUMBER
1795	

MAIL DATE	DELIVERY MODE
06/02/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/816,168	NAKADA ET AL.	
	Examiner	Art Unit	
	EDNA WONG	1795	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 April 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *12 and 14-18* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *12 and 14-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

This is in response to the Amendment dated April 28, 2008. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office Action.

Response to Arguments

Specification

The disclosure has been objected to because of minor informalities.

The objection of the disclosure has been withdrawn in view of Applicants' amendment.

Claim Rejections - 35 USC § 103

Claims 12-18 have been rejected under 35 U.S.C. 103(a) as being unpatentable over **Mikkola et al.** (US Patent Application Publication No. 2004/0217009 A1) in combination with **Tench et al.** (US Patent No. 6,989,084 B2).

The rejection of claims 12-18 under 35 U.S.C. 103(a) as being unpatentable over Mikkola et al. in combination with Tench et al. has been withdrawn in view of Applicants' amendment.

Response to Amendment

Claim Rejections - 35 USC § 103

Claims **12 and 14-18** are rejected under 35 U.S.C. 103(a) as being unpatentable

over **Mikkola et al.** (US Patent Application Publication No. 2004/0217009 A1) in combination with **Tench et al.** (US Patent No. 6,989,084 B2) and **Landau et al.** (US Patent No. 6,113,771).

Mikkola teaches a plating method for forming a plating film (= depositing a layer of copper) [page 4, [0040]] on a conductor layer (= an underlying conductive seed layer) [page 4, [0042]], which is formed on at least a part of a structural object (= an integrated circuit) [page 5, [0046]] having a concave-convex pattern (= small apertures, e.g., 0.18 μm or smaller) [page 4, [0042]] on a semiconductor substrate (= a semiconductor wafer) [page 5, [0050]], comprising:

providing a cathode potential to the conductor layer (= the seed layer = the cathode) [page 6, [0054]]; and

supplying a plating solution (= a copper plating bath) [page 4, [0040]] which electrically connects an anode with the conductor layer (= the seed layer = the cathode) [page 6, [0054]],

wherein the plating solution contains 25-75 g/l of copper ion (= 15 to 65 g/L of copper ions) [page 2, [0018]] and 0.4 mol/l or more of an organic acid or inorganic acid (= 0-100g/L of acid electrolyte) [page 2, [0019] and [0022]] and a porous membrane is installed between the conductor layer and the anode (= the anode and cathode are in intimate contact, being separated by a porous membrane) [page 6, [0054]].

The organic acid or inorganic acid is sulfuric acid, alkane sulfonic acid, or alkanol sulfonic acid (page 2, [0019]).

A copper compound selected from the group consisting of copper sulfate, copper oxide, copper chloride, copper carbonate, copper pyrophosphate, copper alkane sulfonate, copper alkanol sulfonate, and organic acid copper is used as a copper ion source (page 2, [0018]).

The organic acid or inorganic acid is sulfuric acid (page 2, [0019]) and the copper ion source is copper sulfate (page 2, [0018]).

The organic acid or inorganic acid is sulfuric acid (page 2, [0019]), the copper ion source is copper sulfate (page 2, [0018]), and the copper ion concentration is 58 g/l or less (= 15 to 65 g/L of copper ions) [page 2, [0018]].

The concave-convex pattern formed on a semiconductor substrate comprises a pattern with a wiring width or via of 0.1 μm or less (= 0.1 μm wide) [page 6, [0054]].

The method of Mikkola differs from the instant invention because Mikkola does not disclose the following:

a. Wherein the porous membrane is an electric resistor, as recited in claim 12.

Mikkola teaches that the anode and cathode are in intimate contact, being separated by a porous membrane (page 6, [0054]).

Like Mikkola, *Tench* teaches a method for electroplating a semiconductor wafer. Tench teaches that a solution barrier **243** may comprise of *an ion conducting membrane or a porous insulating material* (e.g., plastic, glass or ceramic frit) in the form of a

substantially continuous sheet or multiple discrete elements. A solution barrier of relatively high electrical resistance also provides the equivalent of a large anode to cathode separation so that uniform metal deposition can be obtained over the surface of wafer **230** with a small volume of catholyte, which increases wafer plating throughput by decreasing the time required for filling and draining the catholyte (col. 5, lines 53-66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the porous membrane described by Mikkola with wherein the porous membrane is an electric resistor because a solution barrier of relatively high electrical resistance would have provided the equivalent of a large anode to cathode separation so that uniform metal deposition can be obtained over the surface of wafer with a small volume of catholyte, which would have increased wafer plating throughput by decreasing the time required for filling and draining the catholyte as taught by Tench (col. 5, lines 53-66).

b. Wherein the method is carried out at an electrical conductivity of 3 S/m or less, as recited in claim 12.

Like Mikkola, *Landau* teaches electroplating copper within sub-micron apertures. Landau teaches when uniformity is a primary concern, it is desirable to have a high resistance within the electrolyte. Since the electrolyte resistance is given by $1/\kappa\pi r^2$, it is advantageous to have as low a conductivity, κ, as possible, and also a large gap, 1, between the anode and the cathode. Also, clearly, as the substrate radius, r,

becomes larger, such as when scaling up from 200 mm wafers to 300 mm wafers, the terminal effect will be much more severe (e.g., by a factor of 2.25). By eliminating the acid, the conductivity of the copper plating electrolyte typically drops from about 0.5 S/cm (0.5 $ohm^{-1}cm^{-1}$) to about 1/10 of this value, i.e., ***to about 0.05 S/cm***, making the electrolyte ten times more resistive. The substrate electronical resistivity is between 0.001 and 1000 Ohms/square cm (col. 3, line 59 to col. 4, line 5).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Mikkola with wherein the method is carried out at an electrical conductivity of 3 S/m or less because when uniformity was a primary concern, it was desirable to have a high resistance within the electrolyte as taught by Landau (col. 3, line 33 to col. 4, line 5).

Landau teaches about 0.05 S/cm (= ***about 5 S/m***). Present claim 1, line 14, recites "***3 S/m*** or less." The word "about" (in the teachings of Landau) permits some tolerance or flexibility to the claimed range. *In re Ayers* 69 USPQ 109 and *In re Erickson* 145 USPQ 207 and MPEP § 2173.05(b)(A).

In the case where the claimed ranges overlap or lie inside ranges disclosed by the prior art, a *prima facie* case of obviousness exists (MPEP § 2144.05(I)).

Furthermore, a *prima facie* case of obviousness exists where claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties (MPEP § 2144.05(I)).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EDNA WONG whose telephone number is (571) 272-1349. The examiner can normally be reached on Mon-Fri 7:30 am to 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on (571) 272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Edna Wong/
Primary Examiner
Art Unit 1795

EW
May 26, 2008